

## CONTENTS

1. BACKGROUND .....	1-1
1.1 WILLAMETTE PROJECT AUTHORIZATIONS .....	1-1
1.1.1 The Flood Control Act of 1950 and House Document 531.....	1-3
1.1.1.1 Volume 1, The Willamette River Subbasin Discussion.....	1-4
1.1.1.2 Volume 5, General Background Data .....	1-6
1.2 OPERATIONAL FLEXIBILITY, COORDINATION, AND DISCRETIONARY MANAGEMENT .....	1-7
1.3 FEDERAL ENDANGERED SPECIES ACT LISTED SPECIES.....	1-7
1.4 THIS BIOLOGICAL ASSESSMENT AND THE CONSULTATION PROCESS .....	1-8
1.4.1 Action Agencies .....	1-10
1.4.1.1 Bureau of Reclamation .....	1-11
1.4.1.2 Bonneville Power Administration.....	1-11
1.4.1.3 Other Agencies Indirectly Involved with this Consultation .....	1-14
1.4.2 History of This Consultation .....	1-15
1.4.2.1 Hatchery Consultation .....	1-17
1.4.3 Definitions Concerning the Conclusions Made by this Biological Assessment .....	1-18
1.5 INTERRELATED AND INTERDEPENDENT USACE ACTIONS OCCURRING WITHIN THE WILLAMETTE RIVER BASIN THAT ARE A PART OF THIS CONSULTATION .....	1-19
1.6 OTHER USACE ACTIONS OCCURRING WITHIN THE WILLAMETTE RIVER BASIN THAT ARE NOT A PART OF THIS CONSULTATION .....	1-22
1.6.1 General Investigations and Continuing Authorities Programs .....	1-22
1.6.1.1 Section 1135 Environmental Restoration Projects .....	1-23
1.6.1.2 Section 206 Aquatic Ecosystem Restoration Projects .....	1-24
1.6.2 Miscellaneous Programs.....	1-25
1.7 ORGANIZATION OF THIS BIOLOGICAL ASSESSMENT .....	1-26

2. DESCRIPTION OF THE ACTION UNDER CONSULTATION .....	2-1
2.1 GENERAL DESCRIPTION OF PROJECT OPERATIONS.....	2-2
2.1.1 Project Administration.....	2-2
2.1.2 USACE Master Planning.....	2-4
2.1.3 Project Operations Described by Purpose .....	2-6
2.1.3.1 Flood Control .....	2-6
2.1.3.2 Irrigation .....	2-11
2.1.3.3 Municipal and Industrial Water Supply .....	2-14
2.1.3.4 Navigation.....	2-14
2.1.3.5 Flow Augmentation .....	2-15
2.1.3.6 Hydroelectric Power Generation.....	2-18
2.1.3.7 Recreation .....	2-19
2.1.4 Fisheries Mitigation.....	2-20
2.1.5 System Operation .....	2-21
2.1.6 Land Use Management.....	2-23
2.2 DESCRIPTION OF DETROIT AND BIG CLIFF PROJECTS.....	2-23
2.2.1 Project Information.....	2-23
2.2.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-25
2.2.2.1 Hatchery Production .....	2-26
2.2.2.2 Water Temperature Control Project.....	2-26
2.2.3 USACE Project Lands.....	2-27
2.3 DESCRIPTION OF GREEN PETER AND FOSTER PROJECTS.....	2-28
2.3.1 Project Information.....	2-28
2.3.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-29
2.3.2.1 Upstream-Migrant Passage Facilities at Foster Dam.....	2-30
2.3.2.2 Upstream-Migrant Passage Facilities at Green Peter Dam.....	2-31
2.3.2.3 Downstream-Migrant Passage Facilities at Foster Dam.....	2-32
2.3.2.4 Downstream-Migrant Passage Facilities at Green Peter Dam .....	2-32
2.3.2.5 Hatchery Production .....	2-34
2.3.2.6 Water Temperature Control Project.....	2-34

2.3.3 USACE Project Lands.....	2-35
2.4 DESCRIPTION OF BLUE RIVER PROJECT .....	2-38
2.4.1 Project Information.....	2-38
2.4.2 Fish Passage, Protection, Mitigation, and Enhancement Measures .....	2-39
2.4.2.1 Water Temperature Control Project.....	2-39
2.4.3 USACE Project Lands.....	2-40
2.5 DESCRIPTION OF COUGAR PROJECT .....	2-41
2.5.1 Project Information.....	2-41
2.5.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-42
2.5.2.1 Fish Passage Facilities .....	2-42
2.5.2.2 Hatcheries .....	2-43
2.5.2.3 Water Temperature Control Project.....	2-44
2.5.3 USACE Project Lands.....	2-45
2.6 DESCRIPTION OF FALL CREEK PROJECT .....	2-46
2.6.1 Project Information.....	2-46
2.6.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-47
2.6.2.1 Upstream-Migrant Passage Facilities .....	2-47
2.6.2.2 Downstream-Migrant Passage Facilities.....	2-47
2.6.3 USACE Project Lands.....	2-49
2.7 DESCRIPTION OF HILLS CREEK PROJECT .....	2-51
2.7.1 Project Information.....	2-51
2.7.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-52
2.7.3 USACE Project Lands.....	2-52
2.8 DESCRIPTION OF LOOKOUT POINT AND DEXTER PROJECTS .....	2-54
2.8.1 Project Information.....	2-54
2.8.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-55
2.8.3 USACE Project Lands.....	2-56
2.9 DESCRIPTION OF DORENA PROJECT .....	2-60

2.9.1 Project Information.....	2-60
2.9.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-61
2.9.3 USACE Project Lands.....	2-61
2.10 DESCRIPTION OF COTTAGE GROVE PROJECT .....	2-63
2.10.1 Project Information.....	2-63
2.10.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-64
2.10.3 USACE Project Lands.....	2-64
2.11 DESCRIPTION OF FERN RIDGE PROJECT .....	2-66
2.11.1 Project Information.....	2-66
2.11.2 Passage, Protection, Mitigation, and Enhancement Measures for Fish.....	2-67
2.11.3 USACE Project Lands.....	2-67
2.12 BANK PROTECTION PROGRAM .....	2-69
2.13 MONITORING PROGRAMS.....	2-80
2.14 EMERGENCY ASSISTANCE PROGRAM.....	2-80
3. METHODS .....	3-1
4. BIOLOGICAL INFORMATION FOR LISTED SPECIES .....	4-1
4.1 FISH .....	4-1
4.1.1 Upper Willamette River Spring Chinook Salmon ESU .....	4-1
4.1.1.1 Subpopulations and Distributions .....	4-6
4.1.1.1.1 Historic Distribution.....	4-8
4.1.1.1.2 Present Distribution.....	4-12
4.1.1.2 Population Trends .....	4-14
4.1.1.2.1 Run and Catch Sizes.....	4-14
4.1.1.2.2 Hatchery Contribution To Natural Production .....	4-22
4.1.1.2.3 Current Hatchery Fish Releases .....	4-24
4.1.1.3 Life History.....	4-25
4.1.1.3.1 Spawning .....	4-27
4.1.1.3.2 Incubation.....	4-29
4.1.1.3.3 Juvenile Rearing .....	4-29

4.1.1.3.4 Outmigration.....	4-30
4.1.1.3.5 Ocean Stage.....	4-32
4.1.1.3.6 Age At Maturity .....	4-32
4.1.1.4 Existing Recovery Efforts.....	4-32
4.1.2 Lower Columbia River Chinook Salmon ESU .....	4-34
4.1.2.1 Subpopulations and Distributions .....	4-35
4.1.2.2 Population Trends .....	4-35
4.1.2.2.1 Run and Catch Sizes.....	4-36
4.1.2.2.2 Hatchery Contribution To Natural Production.....	4-36
4.1.2.2.3 Current Hatchery Fish Releases .....	4-38
4.1.2.3 Life History.....	4-38
4.1.2.3.1 Spawning .....	4-38
4.1.2.3.2 Incubation .....	4-39
4.1.2.3.3 Juvenile Rearing and Outmigration.....	4-39
4.1.2.3.4 Ocean Stage.....	4-39
4.1.2.3.5 Age At Maturity .....	4-40
4.1.2.4 Existing Recovery Efforts.....	4-40
4.1.3 Upper Willamette River Steelhead ESU .....	4-41
4.1.3.1 Subpopulations and Distributions .....	4-41
4.1.3.2 Population Trends .....	4-44
4.1.3.2.1 Run and Catch Sizes.....	4-44
4.1.3.2.2 Hatchery Contribution To Natural Production.....	4-46
4.1.3.2.3 Current Hatchery Fish Releases .....	4-48
4.1.3.3 Life History.....	4-48
4.1.3.3.1 Spawning .....	4-48
4.1.3.3.2 Incubation .....	4-50
4.1.3.3.3 Juvenile Rearing and Outmigration.....	4-50
4.1.3.3.4 Ocean Stage.....	4-51
4.1.3.3.5 Age At Maturity .....	4-51
4.1.3.4 Existing Recovery Efforts.....	4-52
4.1.4 Lower Columbia River Steelhead ESU .....	4-55
4.1.4.1 Subpopulations and Distributions .....	4-55
4.1.4.2 Population Trends .....	4-55
4.1.4.2.1 Run and Catch Sizes.....	4-56

4.1.4.2.2 Hatchery Contribution To Natural Production .....	4-56
4.1.4.2.3 Current Hatchery Fish Releases .....	4-58
4.1.4.3 Life History.....	4-58
4.1.4.3.1 Spawning .....	4-58
4.1.4.3.2 Incubation.....	4-59
4.1.4.3.3 Juvenile Rearing and Outmigration.....	4-59
4.1.4.3.4 Ocean Stage.....	4-59
4.1.4.3.5 Age At Maturity .....	4-59
4.1.4.4 Existing Recovery Efforts.....	4-59
4.1.5 Lower Columbia River/Southwest Washington Coho Salmon ESU .....	4-60
4.1.5.1 Subpopulations and Distributions .....	4-60
4.1.5.2 Population Trends .....	4-61
4.1.5.2.1 Run and Catch Sizes.....	4-61
4.1.5.2.2 Hatchery Contribution To Natural Production .....	4-63
4.1.5.2.3 Current Hatchery Fish Releases .....	4-65
4.1.5.3 Life History.....	4-65
4.1.5.3.1 Spawning .....	4-65
4.1.5.3.2 Incubation.....	4-66
4.1.5.3.3 Juvenile Rearing and Outmigration.....	4-66
4.1.5.3.4 Ocean Stage.....	4-66
4.1.5.3.5 Age At Maturity .....	4-67
4.1.5.4 Existing Recovery Efforts.....	4-67
4.1.6 Columbia River Chum Salmon ESU.....	4-68
4.1.6.1 Subpopulations and Distributions .....	4-68
4.1.6.2 Population Trends .....	4-69
4.1.6.2.1 Run and Catch Sizes.....	4-69
4.1.6.2.2 Hatchery Contribution To Natural Production .....	4-69
4.1.6.2.3 Current Hatchery Fish Releases .....	4-70
4.1.6.3 Life History.....	4-71
4.1.6.3.1 Spawning .....	4-71
4.1.6.3.2 Incubation.....	4-72
4.1.6.3.3 Juvenile Rearing and Outmigration.....	4-72
4.1.6.3.4 Ocean Stage.....	4-72
4.1.6.3.5 Age At Maturity .....	4-73
4.1.6.4 Existing Recovery Efforts.....	4-73

4.1.7 Columbia River Bull Trout DPS .....	4-74
4.1.7.1 Subpopulations, Distributions, and Genetic Interactions.....	4-74
4.1.7.2 Population Trends .....	4-78
4.1.7.2.1 Population Size and Redd Counts .....	4-79
4.1.7.2.2 Past and Current Stocking Practices.....	4-80
4.1.7.3 Life History.....	4-80
4.1.7.3.1 Spawning .....	4-81
4.1.7.3.2 Incubation.....	4-82
4.1.7.3.3 Juvenile Rearing and Migration .....	4-83
4.1.7.3.4 Lake and Fluvial Stage .....	4-83
4.1.7.3.5 Age at Maturity.....	4-83
4.1.7.4 Existing Recovery Efforts.....	4-84
4.1.8 Southwest Washington/Lower Columbia Cutthroat Trout ESU .....	4-85
4.1.8.1 Subpopulations and Distributions.....	4-85
4.1.8.2 Population Trends .....	4-85
4.1.8.2.1 Population and Catch Sizes .....	4-86
4.1.8.2.2 Hatchery Contribution To Natural Production.....	4-87
4.1.8.2.3 Current Hatchery Fish Releases .....	4-87
4.1.8.3 Life History.....	4-88
4.1.8.3.1 Spawning .....	4-89
4.1.8.3.2 Incubation.....	4-89
4.1.8.3.3 Juvenile Rearing and Outmigration.....	4-89
4.1.8.3.4 Ocean Stage .....	4-90
4.1.8.3.5 Age At Maturity .....	4-90
4.1.8.4 Existing Recovery Efforts.....	4-90
4.1.9 Upper Willamette River Cutthroat Trout DPS .....	4-91
4.1.9.1 Subpopulations and Distributions .....	4-91
4.1.9.2 Population Trends .....	4-91
4.1.9.2.1 Population and Catch Sizes .....	4-92
4.1.9.2.2 Hatchery Contribution To Natural Production.....	4-92
4.1.9.2.3 Current Hatchery Fish Releases .....	4-93
4.1.9.3 Life History.....	4-93
4.1.9.3.1 Spawning .....	4-93
4.1.9.3.2 Juvenile Rearing and Migration .....	4-93

4.1.9.3.3 Fluvial/Reservoir Stage .....	4-93
4.1.9.3.4 Age At Maturity .....	4-94
4.1.10 Oregon Chub .....	4-94
4.1.10.1 Distributions and Population Size.....	4-94
4.1.10.2 Population Trends .....	4-95
4.1.10.3 Life History.....	4-95
4.1.10.3.1 Spawning and Incubation .....	4-96
4.1.10.3.2 Rearing and Migration.....	4-96
4.1.10.3.3 Age at Maturity.....	4-96
4.1.10.4 Existing Recovery Efforts.....	4-96
4.2 WILDLIFE.....	4-97
4.2.1 Gray Wolf.....	4-97
4.2.2 Columbian White-tailed Deer.....	4-97
4.2.3 Marbled Murrelet.....	4-98
4.2.4 Aleutian Canada Goose .....	4-98
4.2.5 Bald Eagle .....	4-99
4.2.6 Northern Spotted Owl.....	4-100
4.2.7 Fender's Blue Butterfly .....	4-100
4.2.8 Canada Lynx.....	4-101
4.3 PLANTS .....	4-102
4.3.1 Golden Paintbrush .....	4-102
4.3.2 Howellia .....	4-102
4.3.3 Bradshaw's Desert Parsley .....	4-103
4.3.4 Nelson's Checker-mallow .....	4-103
4.3.5 Willamette Daisy .....	4-104
4.3.6 Kincaid's Lupine .....	4-104
5. ENVIRONMENTAL BASELINE.....	5-1
5.1 MAINSTEM WILLAMETTE RIVER.....	5-3
5.1.1 Hydrology.....	5-9
5.1.2 Sediment Transport .....	5-14

5.1.3 Bank Protection and Channelization .....	5-16
5.1.4 Floodplain Maintenance and Side Channel Connectivity .....	5-17
5.1.5 Large Woody Debris Transport.....	5-18
5.1.6 Fish Habitat .....	5-19
5.1.7 Fish Distribution.....	5-23
5.2 SANTIAM RIVER .....	5-27
5.2.1 North Santiam River.....	5-28
5.2.1.1 Hydrology .....	5-30
5.2.1.2 Sediment Transport.....	5-31
5.2.1.3 Bank Protection and Channelization.....	5-33
5.2.1.4 Floodplain Maintenance and Side Channel Connectivity.....	5-33
5.2.1.5 Large Woody Debris Transport .....	5-34
5.2.1.6 Fish Habitat.....	5-34
5.2.1.7 Fish Distribution .....	5-35
5.2.2 South Santiam River.....	5-37
5.2.2.1 Hydrology .....	5-39
5.2.2.2 Sediment Transport.....	5-40
5.2.2.3 Bank Protection and Channelization.....	5-40
5.2.2.4 Floodplain Maintenance and Side Channel Connectivity.....	5-41
5.2.2.5 Large Woody Debris Transport .....	5-41
5.2.2.6 Fish Habitat.....	5-41
5.2.2.7 Fish Distribution .....	5-43
5.3 MCKENZIE RIVER .....	5-45
5.3.1 Hydrology.....	5-48
5.3.2 Sediment Transport .....	5-49
5.3.3 Bank Protection and Channelization .....	5-51
5.3.4 Floodplain Maintenance and Side Channel Connectivity .....	5-51
5.3.5 Large Woody Debris Transport.....	5-52
5.3.6 Fish Habitat .....	5-53
5.3.7 Fish Distribution.....	5-54

5.4 MIDDLE FORK WILLAMETTE RIVER.....	5-57
5.4.1 Hydrology.....	5-59
5.4.2 Sediment Transport .....	5-60
5.4.3 Bank Protection and Channelization .....	5-60
5.4.4 Floodplain maintenance and side channel connectivity .....	5-61
5.4.5 Large Woody Debris Transport.....	5-61
5.4.6 Fish Habitat .....	5-61
5.4.7 Fish Distribution.....	5-64
5.5 COAST FORK WILLAMETTE RIVER.....	5-66
5.5.1 Hydrology.....	5-68
5.5.2 Sediment Transport .....	5-69
5.5.3 Bank Protection and Channelization .....	5-70
5.5.4 Floodplain Maintenance and Side Channel Connectivity .....	5-70
5.5.5 Large Woody Debris Transport.....	5-71
5.5.6 Fish Habitat .....	5-71
5.5.7 Fish Distribution.....	5-72
5.6 LONG TOM RIVER .....	5-73
5.6.1 Hydrology .....	5-74
5.6.2 Sediment Transport .....	5-75
5.6.3 Bank Protection and Channelization .....	5-75
5.6.4 Floodplain Maintenance and Side Channel Connectivity .....	5-76
5.6.5 Large Woody Debris Transport.....	5-76
5.6.6 Fish Habitat .....	5-77
5.6.7 Fish Distribution.....	5-77
5.7 WILDLIFE.....	5-78
5.7.1 Gray Wolf.....	5-78
5.7.2 Columbian White-Tailed Deer .....	5-78
5.7.3 Marbled Murrelet.....	5-79
5.7.4 Aleutian Canada Goose .....	5-79

5.7.5 Bald Eagle .....	5-79
5.7.6 Northern Spotted Owl.....	5-81
5.7.7 Fender's Blue Butterfly .....	5-81
5.7.8 Canada Lynx.....	5-82
5.8 PLANTS .....	5-82
5.8.1 Golden Paintbrush .....	5-82
5.8.2 Howellia .....	5-82
5.8.3 Bradshaw's Desert Parsley .....	5-83
5.8.4 Nelson's Checker-Mallow.....	5-84
5.8.5 Willamette Daisy .....	5-84
5.8.6 Kincaid's Lupine .....	5-84
6. ANALYSIS OF EFFECTS .....	6-1
6.1 EFFECTS ON ESA LISTED FISH SPECIES AND THEIR HABITAT .....	6-1
6.1.1 Effects of Changes in Downstream Hydrography and Water Quantity .....	6-2
6.1.1.1 Potential Effects .....	6-3
6.1.1.2 Effects on Instream Flows and Physical Habitat .....	6-5
6.1.1.3 Effects on Smolt Migration Initiation and Travel Time Below Dams..	6-14
6.1.1.4 Effects of Seasonal Water Management and Flow Fluctuations on Incubation Habitat .....	6-17
6.1.1.5 Effects of Daily Flow Fluctuations (Ramping Rates).....	6-18
6.1.1.6 Effects of Flood Control Operations.....	6-18
6.1.1.7 Specific Hydrographic Effects in Mainstem Willamette River .....	6-21
6.1.1.8 Specific Hydrographic Effects in Santiam River Subbasin .....	6-22
6.1.1.9 Specific Hydrographic Effects in McKenzie River Subbasin.....	6-23
6.1.1.10 Specific Hydrographic Effects in Middle Fork Willamette River Subbasin.....	6-25
6.1.1.11 Specific Hydrographic Effects in Coast Fork Willamette River Subbasin.....	6-26
6.1.1.12 Specific Hydrographic Effects in Long Tom River Subbasin .....	6-27
6.1.2 Water Quality Effects .....	6-27
6.1.2.1 Potential Water Quality Effects .....	6-27

6.1.2.2 Water Temperature Effects .....	6-32
6.1.2.2.1 Specific Biological Effects of Temperature Regime Changes.....	6-35
6.1.2.2.2 Temperature Effects Specific to the Santiam River Subbasin.....	6-36
6.1.2.2.3 Temperature Effects Specific to the McKenzie River Subbasin.....	6-41
6.1.2.2.4 Temperature Effects Specific to the Middle Fork Willamette River Subbasin .....	6-50
6.1.2.2.5 Temperature Effects Specific to the Coast Fork Willamette River Subbasin .....	6-55
6.1.2.2.6 Temperature Effects Specific to the Long Tom River Subbasin.....	6-56
6.1.2.3 Other Water Quality Effects .....	6-56
6.1.2.3.1 Dissolved Oxygen in the Willamette River.....	6-56
6.1.2.3.2 Dissolved Gas Below Willamette Project Dams .....	6-58
6.1.2.3.3 Other Water Quality Parameters in the Willamette River Basin .....	6-60
6.1.2.3.4 Water Quality Effects Specific to Santiam River Subbasin.....	6-62
6.1.2.3.5 Water Quality Effects Specific to McKenzie River Subbasin.....	6-62
6.1.2.3.6 Water Quality Effects Specific to Middle Fork Willamette River Subbasin .....	6-63
6.1.2.3.7 Water Quality Effects Specific to Coast Fork Willamette River Subbasin .....	6-63
6.1.2.3.8 Water Quality Effects Specific to Long Tom River Subbasin.....	6-64
6.1.3 Migration Barriers and Loss of Habitat Above Dams.....	6-64
6.1.3.1 Potential Effects Caused by Dam Construction.....	6-65
6.1.3.2 Summary of Lost and Blocked Habitat for Anadromous Salmonids ...	6-66
6.1.3.3 Barriers to Migration of Anadromous Salmonids.....	6-66
6.1.3.4 Effects of Blockages on Resident Fish Species Metapopulations .....	6-66
6.1.4 Upstream and Downstream Fish Passage Past Dams .....	6-70
6.1.4.1 Potential Passage Effects .....	6-70

6.1.4.2 Santiam River Subbasin.....	6-72
6.1.4.2.1 Passage at Detroit and Big Cliff Dams.....	6-72
6.1.4.2.2 Passage at Green Peter Dam.....	6-73
6.1.4.2.3 Passage at Foster Dam.....	6-75
6.1.4.3 McKenzie River Subbasin .....	6-76
6.1.4.3.1 Passage at Blue River Dam .....	6-76
6.1.4.3.2 Passage at Cougar Dam .....	6-77
6.1.4.4 Middle Fork Willamette River Subbasin.....	6-78
6.1.4.4.1 Passage at Fall Creek Dam .....	6-78
6.1.4.4.2 Passage at Hills Creek Dam .....	6-79
6.1.4.4.3 Passage at Lookout Point and Dexter Dams.....	6-79
6.1.4.5 Coast Fork Willamette River Subbasin.....	6-80
6.1.4.5.1 Passage at Dorena Dam .....	6-80
6.1.4.5.2 Passage at Cottage Grove Dam .....	6-80
6.1.4.6 Passage at Fern Ridge Dam in the Long Tom River Subbasin.....	6-80
6.1.5 Geomorphic Effects.....	6-80
6.1.5.1 Potential Geomorphic Effects .....	6-81
6.1.5.2 Geomorphic Effects Observed Generally in the Willamette River Basin.....	6-82
6.1.5.3 Mainstem Willamette River.....	6-83
6.1.5.4 Santiam River.....	6-84
6.1.5.4.1 North Santiam River.....	6-84
6.1.5.4.2 South Santiam River.....	6-85
6.1.5.5 McKenzie River.....	6-86
6.1.5.6 Middle Fork Willamette River.....	6-87
6.1.5.7 Coast Fork Willamette River .....	6-88
6.1.5.8 Long Tom River.....	6-88
6.1.6 Predation, Exotic Aquatic Animal Species, and Community Species Shifts ...	6-89
6.1.6.1 Potential Effects .....	6-89
6.1.6.2 Effects Common to All or Most Projects.....	6-91
6.1.6.3 Specific Effects in the Santiam River Subbasin .....	6-92
6.1.6.3.1 Detroit and Big Cliff Dams and Reservoirs .....	6-92
6.1.6.3.2 Green Peter Dam and Reservoir .....	6-93
6.1.6.3.3 Foster Dam and Reservoir .....	6-93

6.1.6.4 Specific Effects in the McKenzie River Subbasin.....	6-93
6.1.6.4.1 Blue River Dam and Reservoir.....	6-93
6.1.6.4.2 Cougar Dam and Reservoir .....	6-94
6.1.6.5 Specific Effects in the Middle Fork Willamette River Subbasin.....	6-94
6.1.6.5.1 Fall Creek Dam and Reservoir .....	6-94
6.1.6.5.2 Hills Creek Dam and Reservoir.....	6-94
6.1.6.5.3 Lookout Point and Dexter Dams and Reservoirs .....	6-94
6.1.6.6 Specific Effects in the Coast Fork Willamette River Subbasin .....	6-95
6.1.6.6.1 Dorena Dam and Reservoir .....	6-95
6.1.6.6.2 Cottage Grove Dam and Reservoir.....	6-95
6.1.6.7 Specific Effects of Fern Ridge Dam in the Long Tom River Subbasin .....	6-96
6.1.7 Effects of Recreation and Fishing .....	6-96
6.1.7.1 Potential Effects .....	6-96
6.1.7.2 General Effects Common to All or Most Projects .....	6-97
6.1.7.3 Specific Effects in the Santiam River Subbasin .....	6-100
6.1.7.3.1 Detroit and Big Cliff Dams and Reservoirs .....	6-100
6.1.7.3.2 Green Peter and Foster Dams and Reservoirs .....	6-101
6.1.7.4 Specific Effects in the McKenzie River Subbasin.....	6-103
6.1.7.4.1 Blue River Dam and Reservoir.....	6-103
6.1.7.4.2 Cougar Dam and Reservoir .....	6-104
6.1.7.5 Specific Effects in the Middle Fork Willamette River Subbasin.....	6-106
6.1.7.5.1 Fall Creek Dam and Reservoir .....	6-106
6.1.7.5.2 Hills Creek Dam and Reservoir.....	6-107
6.1.7.5.3 Lookout Point and Dexter Dams and Reservoirs .....	6-107
6.1.7.6 Specific Effects in the Coast Fork Willamette River Subbasin .....	6-109
6.1.7.6.1 Dorena Dam and Reservoir .....	6-109
6.1.7.6.2 Cottage Grove Dam and Reservoir.....	6-109
6.1.7.7 Specific Effects Related to Fern Ridge Dam and Reservoir in the Long Tom River Subbasin.....	6-110
6.1.8 Other Habitat-Related Effects of the Willamette Project and Bank Protection Program .....	6-111
6.1.9 Effects of Hatcheries .....	6-114
6.1.10 Effects of the Willamette Project Downstream of Willamette Falls .....	6-115

6.2 WILDLIFE.....	6-116
6.2.1 Gray Wolf.....	6-116
6.2.2 Columbian White-tailed Deer.....	6-116
6.2.3 Marbled Murrelet.....	6-116
6.2.4 Aleutian Canada Goose .....	6-116
6.2.5 Bald Eagle .....	6-116
6.2.6 Northern Spotted Owl.....	6-117
6.2.7 Fender's Blue Butterfly .....	6-117
6.2.8 Canada Lynx.....	6-117
6.3 PLANTS .....	6-118
6.3.1 Golden Paintbrush .....	6-118
6.3.2 Howellia .....	6-118
6.3.3 Bradshaw's Desert Parsley .....	6-118
6.3.4 Nelson's Checker-mallow .....	6-119
6.3.5 Willamette Daisy .....	6-119
6.3.6 Kincaid's Lupine .....	6-119
6.4 SUMMARY OF EFFECTS .....	6-119
6.4.1 Summary of Effects on Listed Fish Species .....	6-120
6.4.2 Summary of Effects on Listed Wildlife and Plant Species .....	6-120
7. CUMULATIVE EFFECTS .....	7-1
7.1 NON-FEDERAL ACTIVITIES AND CUMULATIVE EFFECTS INFLUENCING LISTED SPECIES IN THE MAINSTEM WILLAMETTE RIVER.....	7-1
7.2 NON-FEDERAL ACTIVITIES AND CUMULATIVE EFFECTS INFLUENCING LISTED SPECIES IN THE SANTIAM RIVER SUBBASIN .....	7-2
7.3 NON-FEDERAL ACTIVITIES AND CUMULATIVE EFFECTS INFLUENCING LISTED SPECIES IN THE MCKENZIE RIVER SUBBASIN .....	7-3
7.4 NON-FEDERAL ACTIVITIES AND CUMULATIVE EFFECTS INFLUENCING LISTED SPECIES IN THE MIDDLE FORK WILLAMETTE RIVER SUBBASIN.....	7-4

7.5 NON-FEDERAL ACTIVITIES AND CUMULATIVE EFFECTS INFLUENCING LISTED SPECIES IN THE COAST FORK WILLAMETTE RIVER SUBBASIN .....	7-4
7.6 NON-FEDERAL ACTIVITIES AND CUMULATIVE EFFECTS INFLUENCING LISTED SPECIES IN THE LONG TOM RIVER SUBBASIN .....	7-5
7.7 CUMULATIVE EFFECTS RELATED TO WATER QUALITY .....	7-5
8. CONCLUSIONS.....	8-1
8.1 FISH SPECIES.....	8-1
8.2 WILDLIFE AND PLANT SPECIES .....	8-1
9. REFERENCES .....	9-1
APPENDIX A:	Plant and Wildlife Candidates and Species of Concern
APPENDIX B:	Land Use, Master Planning, and Resource Management on Project Lands
APPENDIX C:	Dam and Reservoir Schematics
APPENDIX D:	1999 Production Goals of Hatcheries Affiliated with Willamette Project
APPENDIX E:	Rule Curves for Willamette Project Facilities
APPENDIX F:	USGS Flow Data
APPENDIX G:	State of Oregon 303d List Water Quality Impaired Stream Maps